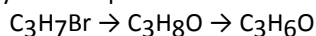


## TAD08 – HL Analytical Practice

Name.....

1. Organic compounds are often identified by using more than one analytical technique. Some of these techniques were used to identify the compounds in the following reactions.

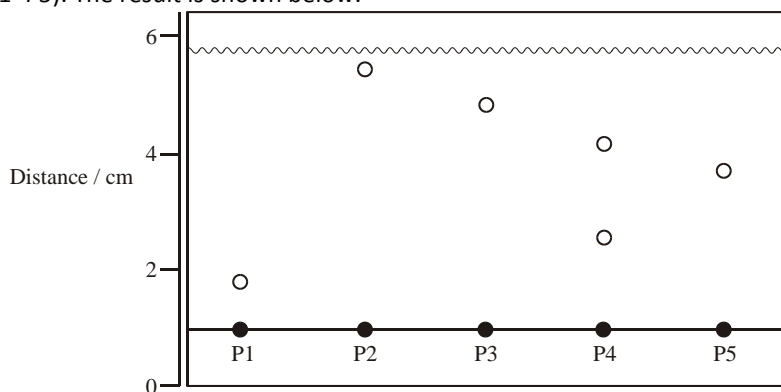


**A                      B                      C**

- (a) Using  $\text{H}_2\text{O}$  as an example, describe what happens, at a molecular level, during the absorption of infrared radiation. (3)
- (b) The infrared spectrum of **B** showed a broad absorption at  $3350\text{ cm}^{-1}$ . The infrared spectrum of **C** did not show this absorption, but instead showed an absorption at  $1720\text{ cm}^{-1}$ . Explain what these results indicate about the structures of **B** and **C**. (2)
- (c) The mass spectrum of **A** showed two lines of approximately equal height, one of which was at  $m/z = 122$ . State the  $m/z$  value of the other line and explain these observations. (3)
- (d) The evidence in (b) and (c) indicates that each compound (**A**, **B** and **C**) could have two possible structures. Draw the two possible structures of **C**. (2)
- (e) Fragmentation of **C** in a mass spectrometer produced lines with  $m/z$  values of 15 and 28, but none at values of 14 or 29. Identify **C** and explain how you used this information to do so. (2)
- (f) State the number of lines in the  $^1\text{H}$  NMR spectrum of each of the structures in (d). (2)

(Total 14 marks)

2. A student used the technique of ascending paper chromatography in an experiment to investigate some permitted food dyes (labeled P1–P5). The result is shown below.



- (a) By reference to the diagram above, describe how the experiment would be carried out and explain the meaning of the terms *stationary phase*, *mobile phase*, *partition*, *solvent front* and *R<sub>f</sub> value*.

(8)

- (b) (i) Calculate the *R<sub>f</sub>* value of P1.

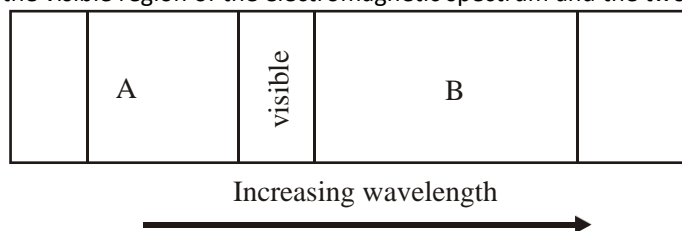
(2)

- (ii) State, giving a reason, whether P4 is a single substance or a mixture.

(1)

**(Total 11 marks)**

3. The figure below depicts the visible region of the electromagnetic spectrum and the two regions nearest to it.



- (a) Name the regions labeled A and B, identify the atomic or molecular processes associated with each region and compare the energies of the photons involved in these processes.

(5)

- (b) State, giving a reason, which region (A or B) could be used to
- (i) test for metal ions.

(1)

- (ii) obtain information about the strengths of bonds.

(1)

**(Total 7 marks)**

4. (a) <sup>1</sup>H NMR spectroscopy can be used to obtain information about the structure of molecules. State the information that can be obtained from the

- (i) number of peaks.

(1)

- (ii) chemical shift.

(1)

- (iii) ratio of peak areas.

(1)

- (iv) splitting pattern.

(1)

- (b) The  $^1\text{H}$  NMR spectrum of a compound with the formula  $\text{C}_4\text{H}_8\text{O}_2$  exhibits three major peaks with chemical shifts, areas and splitting patterns given below.

chemical shift / ppm	peak area	splitting pattern
0.9	3	triplet
2.0	2	quartet
4.1	3	singlet

Using information from Table 19 in the Data Booklet, determine the types of proton present in the molecule.

(3)

- (c) Deduce a structure consistent with the information indicated in (b). Explain your answer.

(5)

(Total 12 marks)

5. (i) Explain, with reference to the d orbitals in a transition metal, why complex ions are colored.

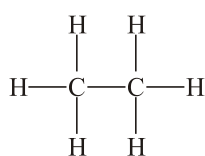
(3)

- (ii) Outline why different ligands produce different colors with the same transition metal.

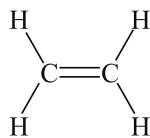
(2)

(Total 5 marks)

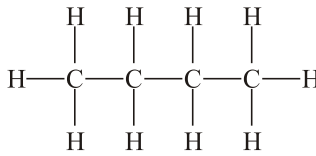
6. The structures of four hydrocarbons are shown below.



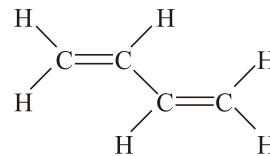
I



II



III



IV

- (i) Identify the compounds that most strongly absorb ultraviolet radiation.

(1)

- (ii) Identify the compound that absorbs ultraviolet radiation of the longest wavelength, and explain your choice.

(2)

(Total 3 marks)